West Nile Virus in the United States, 1999 – 2002

The outbreak of West Nile fever in New York in 1999 illustrates how a mosquito–borne disease that affects both humans and animals can spread. The West Nile virus had never before been reported in this hemisphere. The outbreak provides lessons about detecting and responding to a new disease, including the importance of local disease surveillance and response systems, communication among public health agencies, and links between public and animal health agencies. Veterinarians played an important role in the initial diagnosis of this outbreak. West Nile is now considered a domestic endemic disease.

In early August 1999, Tracy McNamara, DVM, head of the department of pathology at the Bronx Zoo, became concerned when she heard that a large number of crows had been dying around the zoo. By late August, 40 crows had died. Then birds at the zoo began to die. Over the Labor Day weekend, the zoo lost a Guanay Cormorant, three Chilean flamingos, a pheasant, and a bald eagle. Because these deaths followed those of the crows, experts strongly doubted that the disease originated in the zoo. Necropsies of the birds revealed streaking in the heart and brain hemorrhages. Eastern equine encephalitis was suspected but McNamara was skeptical because the emus in her care, which are very susceptible to eastern equine encephalitis virus, were thriving. “It was becoming more and more suggestive that this was not a regular bird disease,” McNamara said. When two more flamingos died on September 9, she sent samples to the USDA’s National Veterinary Services Laboratories (NVSL) in Ames, Iowa. The NVSL ruled out avian influenza and Newcastle disease viruses. The Centers for Disease Control and Prevention (CDC) was also sent samples, as were doctors at an Army laboratory in Fort Detrick, Maryland.

Meanwhile, on August 23, 1999, an infectious disease physician from a hospital in northern Queens contacted the New York City Department of Health (NYCDOH) to report two patients with encephalitis. On investigation, NYCDOH initially identified a cluster of six patients with encephalitis, five of whom had profound muscle weakness. Testing of these initial cases was positive for St. Louis encephalitis virus on September 3 at the CDC. Eight of the earliest case–patients were residents of a 2–by–2–mile area in northern Queens. On the basis of these findings, aerial and ground applications of mosquito adulticides and larvacides were instituted in northern Queens and South Bronx on September 3.

What happened next?

In Ames, Iowa, the NVSL isolated a virus from the birds’ tissues and, after ruling out several viral agents that cause encephalitis in birds, performed an electron microscopy examination. Forty nanometer virus particles with the morphology of togaviruses or

flaviviruses were observed. On September 20, the NVSL forwarded the virus cultures to the CDC for identification and characterization. Testing at the CDC on September 23 indicated that the isolate was closely related to the West Nile virus (WNV), which had never been isolated in the western hemisphere. CDC experts also detected flavivirus antigens in one of the human autopsy specimens by immunohistochemistry and found a West Nile–like virus genomic sequence in a human brain specimen from an encephalitis case; this sequence was identical to that derived from the bird tissues. Concurrently, specimens of brain tissue from three human encephalitis cases, forwarded by the New York State Department of Health to the University of California, Irvine, were reported as positive for the West Nile–like virus sequence by genomic analysis.

By September 28, a total of 17 confirmed and 20 probable human cases and four deaths had been reported in New York City and the surrounding counties. The four deaths occurred among persons over 68 years of age. The onset dates ranged from August 5 to September 16. The median age of the patients was 71 years (range 15–87 years), with the most severe clinical cases and all fatalities occurring among older persons. In October 1999, the NVSL first isolated the West Nile virus from the brain tissue of a Long Island horse that had clinical encephalitis. WNV was also isolated at NVSL from two additional encephalitic horses in 1999 and WNV antibodies were identified in ill horses in Suffolk and Essex counties, New York. Retrospective classification of likely West Nile cases occurring prior to October resulted in a total of 25 equine cases.

What is the West Nile virus?

The West Nile virus is a flavivirus belonging taxonomically to the Japanese encephalitis subgroup that includes St. Louis encephalitis virus, Kunjin virus, Murray Valley encephalitis virus, and others. The West Nile virus was first isolated in the West Nile province of Uganda in 1937. It is a mosquito–transmitted virus that, in endemic regions, cycles between birds and mosquitoes. Many infected birds are asymptomatic, but high mortality rates have been seen in some species – particularly crows, ravens, and jays. When environmental conditions favor high viral amplification, mosquitoes can also spread the virus to mammals. In the northern United States, the West Nile virus has been most closely associated with *Culex pipiens*, a mosquito species that breeds in standing water, especially water polluted with organic matter. It has been thought that these mosquitoes "prefer" to bite birds, but if breeding sites are available near people's homes and domestic animal enclosures, *Culex pipiens* may bite people and domestic animals. *Culex pipiens* is most active at dawn and dusk. Another hypothesis suggests that other species of mosquitoes, not *Culex pipiens*, acts as a "bridge," biting both birds and mammals. Some recent evidence indicates that *Culex salinarius* is responsible for WNV transmission to people. *C. salinarius* is found in fresh and saltwater marshes, lakes, ponds, and seepage areas, as well as in the many types of artificial containers found

around human residences and businesses. This species is active from sunset to sunrise. Like the St. Louis encephalitis virus, the West Nile virus is not transmitted from person to person or from birds to people.

Among mammals, symptomatic infections mainly seem to occur in humans and horses. In humans, many cases of West Nile fever are mild and flu–like; however, in more severe cases, there may be signs of encephalitis, meningoencephalitis or meningitis. Horses develop symptoms of encephalitis, often without a fever. The first recorded epidemics of West Nile fever occurred in Israel during 1950–1954 and in 1957. The largest recorded epidemic occurred in South Africa in 1974. Epidemics were also reported in Europe in the Rhone delta of France in 1962 and in Romania in 1996. The West Nile virus had never been recognized in the United States or any other area of the Western Hemisphere prior to 1999.

The response to the outbreak

Vector control measures had been initiated in northern Queens and the South Bronx on September 3. These measures were followed by a citywide pesticide application, after a laboratory confirmed a case of West Nile encephalitis in a Brooklyn resident with no travel history to Queens and two additional cases in the South Bronx. Surveillance of wild birds and sentinel chickens was instituted to assess WNV distribution in the region. Emergency telephone hotlines were established in New York City on September 3 and in Westchester County on September 21 to address public inquiries about the encephalitis outbreak and pesticide application. Approximately 300,000 cans of DEET–based mosquito repellant were distributed citywide through local firehouses, and 750,000 public health leaflets were distributed with information about personal protection against mosquito bites. Recurring public messages were announced on radio, television, web sites, and in newspapers, urging personal protection against mosquito bites. Recommended actions included limiting outdoor activity during the peak hours of mosquito activity, wearing long–sleeved shirts and long pants, using DEET–based insect repellents, and eliminating any potential mosquito breeding niches. Spraying schedules were also publicized and people were advised to remain indoors during spraying to reduce pesticide exposure.

By the end of 1999, the West Nile virus had been identified in a limited area of the northeastern United States in wild birds, mosquitoes, humans, and horses. Naturally occurring virus had been found in birds and mosquitoes in parts of Connecticut, New York, New Jersey, and in one county in Maryland. Clinical illness in humans and horses occurred during a period from early August through late October and was limited to New York. WNV activity ended for the season because of various factors, including climate and vector control activities. In all, 62 human cases, with seven deaths, were recognized in 1999. A total of 25 cases of West Nile encephalitis were also identified in horses, all in Suffolk and Nassau Counties on Long Island, New York. Because horses are known not

to play a role in the transmission of WNV, quarantines were never placed on any non–clinically ill horses in the outbreak area. However, the movement of horses was restricted, particularly the export of horses from affected areas to the European Union and the shipment of any horses to the E.U. via Kennedy airport.

In genetic sequencing studies, the West Nile virus isolates from the New York outbreak showed strong similarities to isolates from the Middle East, suggesting that this region may have been the origin of the virus. How the West Nile virus was introduced into the United States is unknown, but speculation has centered on infected humans, mosquitoes, or birds being transported by aircraft. Several other speculated routes of entry also exist.

The continuing spread of the West Nile virus

In 2000, 21 human cases of West Nile encephalitis were reported. Two elderly patients, an 82–year–old man in New Jersey and an 87–year–old woman in New York, died of the disease. There were a total of 60 confirmed equine cases in seven states. Of the 60 ill horses, 37 survived and 23 (38%) died or were euthanized. Six wild mammals were classified as WNV–positive and 4,323 infected birds were documented in 12 states plus the District of Columbia. A total of 143 counties in 12 eastern states and the District of Columbia had confirmed findings of WNV in a mosquito, bird, or mammal.

In 2001, the virus spread through bird migration south to Florida, west to Iowa, and north to Canada. There were 66 human cases in 10 states, including nine deaths. As before, most of the cases occurred in older patients; the median age was 68 and the range was 9 to 90 years. A total of 733 equine cases were reported from 127 counties in 19 states, a 12–fold increase from 2000. More than 7,000 WNV–positive wild birds were found in 328 counties in 27 states and the District of Columbia. In 66 percent of the counties, dead crows were the first indication of West Nile virus activity. Positive birds were collected from April to December 2001. West Nile virus did not affect any commercial poultry.

In 2002, the virus continued to spread. By the end of the 2002 mosquito season, the West Nile virus was found throughout the Midwest and was spreading into the western states. More than 4,000 human infections, 284 of them fatal, and more than 14,000 confirmed equine cases were reported. Only Oregon, Nevada, Utah, and Arizona reported no cases in mammals, birds, or mosquitoes as of April 2003.

Sources of Information

New York Times; Sunday, 26 September 1999; via ProMED “African Virus May Be Culprit in Mosquito–Borne Illnesses in New York Region”

http://www.nytimes.com/library/national/regional/092599ny–encephalitis.html

NVSL first to…, ProMED, Tue, 28 Sep 1999 11:30:16 –0500, from Beverly J. Schmitt of the USDA APHIS National Veterinary Services Laboratories.

USDA APHIS VS Website

http://www.aphis.usda.gov/oa/wnv/index.html

West Nile Virus Outbreak, Lessons for Public Health Preparedness, Report to Congressional Requesters, US General Accounting Office (contains timeline information for all WNV–related events in 1999) http://www.gao.gov/ Report Number: HEHS–00–180.

West Nile Encephalitis. EN Ostlund et al. Vet Clin of N. America. 16:427, 2000.

Emerging Infectious Diseases, July – August 2000 issue

www.cdc.gov

Centers for Disease Control:

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5123a1.htm

Cornell University:

http://www.cfe.cornell.edu/erap/wnv/

West Nile Virus Update. Current Case Count. Centers for Disease Control and Prevention, April 15 2003. http://

www.cdc.gov/od/oc/media/wncount.htm

Update on the Current Status of West Nile Virus. Equine Cases of West Nile Virus Illness in 2002: 1 January through 31 December. United States Department of Agriculture.

http://www.aphis.usda.gov/lpa/issues/wnv/wnvstats.html

USGS West Nile Virus Maps – 2002. United States Geological Survey.

http://cindi.usgs.gov/hazard/event/west_nile/west_nile.html